Dynamics of Internal Tides and Near-Inertial Internal Waves

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LONG-TERM GOAL

The long term goal of the research project is the understanding of the oceanic internal gravity wave field as a balance of generation, transfer and dissipation processes, and the construction of a numerical dynamical model (called Internal Wave Action Model, IWAM) that will predict changes of the internal wave field in response to changes in the forcing and environmental fields. The internal wave model will be based on the integration of the radiation balance equation.

OBJECTIVES

The objective of the current project is an analysis of basic scientific and numerical issues that need to be considered when implementing internal tides and near-inertial internal waves into IWAM.

APPROACH

The approach is mainly theoretical and numerical.

WORK COMPLETED

The Internal Wave Action Model (IWAM) is based on the integration of the radiation balance equation, which is based upon three basic assumptions

- the random phase approximation,
- the WKB or geometric optics approximation, and
- the weak interaction approximation.

Internal tidal and near-inertial waves are an important part of the internal wave field. They show up as peaks in the internal wave spectrum. Observations suggest that a large fraction of these waves is in low mode numbers and large horizontal scales and has a beam-like structure. Their incorporation into IWAM represents a major challenge.

Internal tidal and near-inertial waves can either be treated as part of the random internal wave field. Their nonlinear interaction with the background internal wave field (as represented by the Garrett and Munk spectrum) is then governed by a two-dimensional scattering integral. For a directional and

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spatially decaying peak the configuration space is N3 and the complexity of the numerical algorithm hence N5. Internal tides and near-inertial internal waves can alternatively be treated as part of the deterministic fields that are provided to IWAM by a general circulation model. The complexity of the numerical algorithm is then only N3 but at much higher resolution.

The design decision must also be based on various physical issues. Prominent among these are: (1) to what extent can internal tidal and near-inertial waves be treated in the random phase approximation, and (2) do these waves propagate largely unaffected by interactions with the background continuum and break at distant “shores” as “internal swell”; or do these interactions cause the waves to dissipate in the open ocean via a gradual down-scale wave number cascade towards wave breaking? These physical issues are not fully resolved yet.

RESULTS

The research brought into focus the issues that need to be considered or resolved before a rational decision can be made on how to implement internal tidal and near-inertial waves into IWAM.

IMPACT/APPLICATION

The development of a predictive dynamical model of internal wave fields will have many benefits and applications.

Internal wave research will benefit from such a model since

- it will provide understanding of the internal wave field as a balance of generation, transfer and dissipation processes,
- it will focus research (it is expected that the proposed model will do for internal wave dynamics what the GM model did for internal wave kinematics), and
- it will predict changes of the internal wave field in response to changes in the forcing and environmental fields.

The dynamical internal wave model can be run in conjunction with circulation models, turbulence models, chemical tracer models, and biological population models where it would predict the internal wave induced transports, dispersion and mixing. In conjunction with acoustic transmission models the model would predict the internal wave induced “noise.”

TRANSITIONS

RELATED PROJECTS

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